2014 BASELINE GROUNDWATER MONITORING REPORT

DUAL SITE GROUNDWATER OPERABLE UNIT
MONTROSE CHEMICAL AND
DEL AMO SUPERFUND SITES
LOS ANGELES, CALIFORNIA

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ABBREVIATIONS AND ACRONYMS

COCs	constituents of concern
DO	dissolved oxygen
Fe^{+++}	ferric iron
Fe^{++}	ferrous iron
GC/MS	gas chromatography/mass spectrometry
K	hydraulic conductivity
i	gradient
IR	infrared
LBF	Lower Bellflower Aquitard
MACP	Monitoring and Aquifer Compliance Plan
MBFB	Middle Bellflower B Sand
MBFC	Middle Bellflower C Sand
MBFM	Middle Bellflower Mud
µg/l	micrograms per liter
MSL	mean sea level
n	effective porosity
ORP	oxidation reduction potential
OU	Operable Unit
pCBSA	para-chlorobenzene sulfonic acid
PCE	tetrachloroethene
QA/QC	Quality Assurance/Quality Control
ROD	Record of Decision
TBA	tertiary butyl alcohol
TCE	trichloroethene
TI	technical impracticability
UBF	Upper Bellflower
USEPA	U.S. Environmental Protection Agency
V	flow velocity
VOCs	volatile organic compounds

EXECUTIVE SUMMARY

Presented in this document are the results of 2014 Baseline Groundwater Monitoring Event completed in September 2014 for the Del Amo portion of the Dual Groundwater Operable Unit Site (hereafter referred to as "the Site"). Activities were conducted in accordance with the Monitoring and Aquifer Compliance Plan (MACP) submitted to the U.S. Environmental Protection Agency (USEPA) on September 5, 2014. The monitoring program is being conducted to generate groundwater elevation and laboratory analytical data by which to evaluate the extent of the contaminant plume associated with the Site and confirm that biodegradation and containment of the plume is occurring.

The Del Amo Superfund Site is a former synthetic rubber plant that was located on approximately 280 acres near the intersection of the 405 and 110 freeways in the Harbor Gateway portion of Los Angeles, California. The Site and the neighboring Montrose Superfund site to the west have unrelated histories. USEPA has defined groundwater across the two superfund sites as a Dual Site.

Benzene and ethylbenzene are the groundwater constituents of concern (COC) associated with the Site, although the Site is not the sole source of these COCs in the vicinity. Groundwater COCs associated with the Montrose Superfund site include chlorobenzene, DDT, para-chlorobenzene sulfonic acid (pCBSA), and benzene, while other sites in the vicinity are sources of trichloroethene (TCE), and tetrachloroethene (PCE).

The USEPA designated a TI-Waiver Zone in the Dual Site Record of Decision (ROD) where remediation of groundwater to in-situ groundwater standards is not required. In the vicinity of the Site, the extent of the TI-Waiver zone was based on the known extent of the benzene plume at that time. The benzene plume remedy, as outlined in the ROD, consists primarily of monitored intrinsic biodegradation. The remedy for the chlorobenzene plume associated with the Montrose site is hydraulic extraction, which includes a system of extraction wells, groundwater treatment facilities, injection wells and associated piping, collectively referred to as the Torrance Groundwater Remediation System (TGRS).

The following observations are presented based on the data gathered during the 2014 Baseline Groundwater Monitoring Event:

- Groundwater elevations in all hydrostratigraphic units decreased by an average of 0.57 feet since the previous monitoring event in 2012. This drop in water levels is in contrast to the long-term trend of rising groundwater levels in the Dual Site vicinity.
- The groundwater flow direction and average hydraulic gradient for the four water-bearing units are generally consistent with historical data.
- Water table data confirmed the following:

- Non-Aqueous Phase Liquid (NAPL) has historically been present in the Site Water Table wells XMW-20, SWL0001 and MBFB well SWL0032, which are all located near the western Site boundary. NAPL was observed in well SWL0032 during the recent monitoring event (monitor wells XMW-20 and SWL0001 were not gauged during this monitoring event).
- NAPL was detected at well PZL019 during the recent monitoring event. Well PZL019 is located in the western end of the Waste Pits OU and NAPL had not previously been observed in this well.
- The dissolved benzene distribution is generally consistent with historical data although a reduction in concentrations and distribution is evident at the Waste Pits OU. Based on review of chlorobenzene analytical laboratory results, the dissolved benzene concentrations observed in the southwest corner of the Site and on the Montrose site are not associated with historical Site operations.
- Dissolved benzene known to be associated with the Site is entirely within the TI-Waiver Zone. The origin of benzene detected at well PZL0005 in the northeast corner in 2008 (17 µg/l) is unknown, but may originate from off-site given the southwesterly direction of groundwater flow in this area. Benzene was not detected at this location in any previous monitoring events and the anomalous result from 2008 will be further evaluated by sampling this well during the 6-month after TGRS start-up sampling event.
- Mann-Kendall statistical analysis identified 13 wells with a trend of decreasing benzene concentrations through time and no wells with a trend of increasing concentrations. Additionally, benzene was not detected or detected at concentrations less than the MCL (< 1 µg/l) at 32 of the 47 wells sampled. Based on these findings, the dissolved benzene plume is stable to decreasing.
- Biodegradation indicators confirmed that both aerobic and anaerobic biodegradation processes are occurring. These data combined with the dissolved benzene concentration trends confirm that the monitored intrinsic biodegradation remedial approach identified in the ROD is appropriate.

- MBFB data confirmed the following:
  - The dissolved benzene distribution is generally consistent with historical data and the dissolved benzene plume is entirely within the TI-Waiver Zone. Based on review of chlorobenzene analytical laboratory results, the dissolved benzene concentrations observed in the southwest corner of the Site and on the Montrose site are not associated with historical Site operations.
  - Mann-Kendall statistical analysis identified no wells with a trend of decreasing benzene concentrations through time, and one well with a trend of increasing benzene concentrations. Benzene was not detected or detected at concentrations below the MCL (< 1 µg/l) at 12 of the 15 wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.

  - Biodegradation indicators confirmed that both aerobic and anaerobic biodegradation processes are occurring. These data combined with the dissolved benzene concentration trends confirm that the monitored intrinsic biodegradation remedial approach identified in the ROD is appropriate.
- MBFC Sand data confirmed the following:
  - The dissolved benzene distribution is generally consistent with historical data. Dissolved benzene concentrations tend to be lower than in the overlying water table and MBFB water-bearing units, and the dissolved benzene plume associated with the Site is entirely within the TI-Waiver Zone. Based on review of chlorobenzene analytical laboratory results, the dissolved benzene concentrations in the southwest corner of the Site and on the Montrose site are associated with historical Montrose operations and not historical Site operations.
  - Mann-Kendall statistical analysis identified two wells with a trend of decreasing benzene concentrations through time and no wells with a trend of increasing benzene concentrations. Benzene was not detected or detected at concentrations less than the MCL (< 1 µg/l) at 10 of the 16 wells sampled. Based on these findings, the dissolved benzene plume is stable to decreasing.
- Gage Aquifer data confirmed the following:
  - The dissolved benzene distribution is generally consistent with historical data. The dissolved benzene concentrations and distribution are generally lower than in the overlying water table, MBFB and MBFC units. Based on review of chlorobenzene analytical laboratory results, the dissolved benzene concentrations observed in the southwest corner of the Site and on the Montrose site are not associated with historical Site operations.
  - Wells SWL0066 and SWL0063 were not constructed until after the ROD was completed; therefore, the dissolved benzene plume associated with these wells is located outside of the TI-Waiver Zone indicated in the ROD. However, the extent of the plume is limited and future analytical laboratory testing will be utilized to monitor the benzene concentration trends and extent of the plume.
  - Mann-Kendall statistical analysis did not identify any wells with trends of either increasing or decreasing benzene concentrations through time. Benzene was not detected or detected at concentrations less than the MCL (< 1 µg/l) at 3 of the 5 wells sampled. Based on this analysis/data, the dissolved benzene plume is stable to decreasing

Based on the findings summarized above, the following recommendations are made:

HSU	Well	Recommendation	Rationale
Water Table	PZL0002	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0003	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0004	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0005	Gauge and sample well in 6-month event	Further evaluate anomalous benzene detection in 2008 sampling event
	PZL0008	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0015	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0017	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0019	Continue gauging	NAPL present
	SWL0012	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0015	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0028	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0039	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0049	Transfer to Montrose	Not necessary for monitoring of Del Amo benzene plume
	SWL0057	Destroy well	Established history of benzene concentrations below the MCL
MBFB	SWL0011	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0019	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0052	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0056	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
MBFC	SWL0014	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0033	Transfer to Montrose	Contaminants present not associated with Del Amo Site
LBF	SWL0043	Destroy well	Not screened in major HSU; no history of benzene concentrations in excess of MCL
Gage	SWL0031	Previously destroyed by PACCAR	
	SWL0034	Transfer to Montrose	Contaminants present not associated with Del Amo Site
	SWL0067	Transfer to TCE parties	Established history of benzene concentrations below the MCL; TCE present not associated with Del Amo Site

1.0 INTRODUCTION AND BACKGROUND

Presented in this document are the results of groundwater monitoring completed in September 2014 for the Del Amo Superfund Site (hereafter referred to as "the Site"). The groundwater monitoring was conducted in accordance with the Monitoring and Aquifer Compliance Plan (MACP) prepared by URS on behalf of Shell Oil Company (URS, 2014) and submitted to the U.S. Environmental Protection Agency on September 5, 2014. Both the monitoring event and the MACP were completed in response to USEPA requests pending negotiation and execution of a Consent Decree for operation and maintenance of the groundwater remedy specified in USEPA's 1999 Record of Decision (ROD) for the Dual Site Groundwater Operable Unit (OU), Montrose Chemical and Del Amo Superfund sites. A separate MACP and monitoring event were completed for the Montrose Superfund Site by AECOM.

The 2014 Baseline Groundwater Monitoring Event focused on the measurement of groundwater levels and the collection of groundwater samples for laboratory analysis. The field work described herein was conducted contemporaneously with similar groundwater monitoring efforts completed for the Montrose site and other nearby sites by other consultants.

The Site is a former synthetic rubber plant that was located on approximately 280 acres near the intersection of the 405 and 110 freeways in the Harbor Gateway portion of Los Angeles, California (Figure 1). The Del Amo and Montrose Superfund sites have unrelated histories but have historically been considered a Dual Site by USEPA with respect to the Groundwater OU and associated remedial design investigations.

Benzene is the principal groundwater constituent of concern (COCs) associated with the Site, although the Site is not the sole source of benzene in the vicinity. Groundwater COCs associated with the Montrose Superfund site include chlorobenzene, DDT, para-chlorobenzene sulfonic acid (pCBSA) and benzene. Multiple groundwater contamination sources are present in the vicinity of the Dual Site, some of which are unrelated to either the Del Amo or Montrose sites and are associated with releases of trichloroethene (TCE), and tetrachloroethene (PCE).

USEPA designated a technical impracticability zone (TI-Waiver Zone; also referred to as the containment zone) in the Dual Site ROD where remediation of groundwater to in-situ groundwater standards is not required. In the vicinity of the Site, the TI-Waiver Zone was based on the known extent of the benzene plume at the time the ROD was written.

2.0 PURPOSE AND SCOPE

2.1 PURPOSE

The MACP includes baseline, 6-month, 1-year, year 2+ annual, and 5-year groundwater monitoring events. The objective of the baseline event is to establish groundwater conditions prior to start-up of the Montrose TGRS. The 6-month and 1-year events are one-time events to evaluate changes in conditions in the initial period following start-up of the treatment system. The subsequent year 2+ annual events have a reduced scope, and are intended to provide longer term confirmation of plume containment, while the 5-year event provides a more comprehensive check on remedy performance. Based on these objectives, the baseline and 5-year events are very similar in scope, as are the 6-month and 1-year events. The monitoring program for each event is summarized in Table 1.

The MACP is evergreen and based on potential changes in hydraulic gradients, COC concentration distribution, and biodegradation indicator results, modifications to the testing program included in the MACP may be required in the future.

The monitoring program is being conducted to generate groundwater elevation and laboratory analytical data by which to evaluate the extent of the COC plume associated with the Site and confirm that biodegradation and containment of the plume is occurring. ROD requirements pertaining to the MACP and the Site include the following:

- Collection of groundwater elevation data sufficient to generate elevation contour maps, evaluate hydraulic gradients, determine flow velocities and evaluate the effect of hydraulic extraction for the affected hydrostratigraphic units;
- Evaluation of the lateral and vertical distribution and movement of COCs, particularly with respect to benzene; and
- Confirmation that COCs have not migrated outside the TI-Waiver Zone and that intrinsic biodegradation remains a reliable method for containment of the Site benzene plume.

2.2 SCOPE

The Baseline Groundwater Monitoring Event was completed to establish groundwater conditions in the vicinity of the Site prior to the start-up of the Montrose TGRS. The following tasks were completed as part of the investigation:

- Measurement of groundwater levels at 88 monitoring wells;
- Purging, field parameter measurement, and collection of groundwater samples at 85 monitoring wells;

- Laboratory analysis of groundwater samples from 85 wells for volatile organic compounds (VOCs);
- Laboratory analysis of groundwater samples from 20 wells for tertiary butyl alcohol (TBA);
- Laboratory analysis of groundwater samples from 21 wells for biodegradation indicators;
- Laboratory analysis of Quality Assurance/Quality Control (QA/QC) samples to aid in subsequent evaluation of data quality; and
- Evaluation of the data and preparation of this report.

Monitoring wells included in the Baseline Groundwater Monitoring Event are listed in Table 1 along with their location-specific scope and analytical program.

Field activities were completed in general accordance with the previously prepared and USEPA-approved Field Sampling Plan and Quality Assurance Project Plan (URS, 2004). Further details regarding the completed scope of work and results are provided in Sections 4, 5, and 6.

3.0 HYDROSTRATIGRAPHY REVIEW

The subsurface in the vicinity of the Dual Site OU includes the Bellflower Aquitard and the underlying Gage and Lynwood aquifers. The Bellflower Aquitard is subdivided into the Upper Bellflower (UBF), Middle Bellflower B Sand (MBFB), Middle Bellflower Mud (MBFM), Middle Bellflower C Sand (MBFC), and the Lower Bellflower Aquitard (LBF). A schematic diagram showing the relative positions of the hydrostratigraphic units is presented on Figure 2.

The Site monitoring well network targets the primary water-bearing units which are limited to the UBF, MBFB, MBFC and the Gage Aquifer. The upper most hydrostratigraphic unit is the UBF, with an average thickness of 74 feet in the Site vicinity. This unit consists of laminated to massive muds up to 30 feet thick with local discontinuous sands and fossiliferous zones. The MBFB is a fine sand with minor muddy layers and laminations. This unit is present only in the western portion of the Site and has an average thickness of 15 feet that tapers out toward the central portion of the Site. The MBFC is a thick body of fine to medium sand with local muddy layers and lenses with an average thickness of approximately 43 feet. The MBFB and MBFC are merged over a significant portion of the Site (i.e. the intervening MBFM is not always present). The Gage aquifer averages 66 feet thick, consisting of massive to cross-stratified clean sands and a distinctive fossiliferous layer.

4.0 GROUNDWATER ELEVATIONS AND FLOW

Groundwater level measurements for the Site were generally completed between September 2 and 4, 2014 using an electronic water level indicator or interface probe. Measurements for eight wells were completed on September 9 and 25, 2014 due to a delay in gaining property access. Depth to groundwater measurements were converted to groundwater elevations relative to mean sea level (MSL) using surveyed elevations for fixed measuring points at each monitoring location. Groundwater elevation data are presented in Table 2 and include data generated by other investigators for the Montrose site, as well as historical groundwater elevation data for comparison. Groundwater elevations in all hydrostratigraphic units decreased by an average of 0.57 feet since the previous monitoring event in 2012. This drop in water levels is in contrast to the long-term trend of rising groundwater levels in the Site vicinity. The data for each hydrostratigraphic unit are further discussed below.

Due to the east-northeasterly inclination of the hydrostratigraphic units, the Water Table is present in the UBF over most of the Site but in the MBFB further west (Figure 2). For presentation purposes, groundwater elevations and dissolved benzene plumes are presented with respect to the Water Table, MBFB, MBFC and Gage Aquifer and the Water Table and MBFB units are therefore identical in the western portion of the Site and further west.

4.1 WATER TABLE

Figure 3 presents interpretive groundwater elevation contours for the Water Table during the recent monitoring event. Water Table elevations within the Site ranged from a high of -8.56 feet MSL at well SWL0038 in the northwest corner, to a low of -10.57 feet MSL at well XMW-28, near the southwest corner. Water Table elevations were on average approximately 0.60 feet lower than those for the previous monitoring event in 2012.

The water table flow direction is generally southwesterly at an average gradient of 0.0006, but is highly variable. The average flow velocity is calculated as follows:

$V = K(i) / n$

Where V = flow velocity
K = hydraulic conductivity = 3.0 feet/day
i = gradient = 0.0006 (unitless)
n = effective porosity = 0.15 (unitless)

Values for K and n are consistent with those used in the Groundwater Remedial Investigation Report (Dames & Moore, 1998) and are based on previously completed constant discharge/slug

testing and physical testing of numerous UBF soil samples, respectively. Using the above values, the water table flow velocity is calculated to be approximately 0.01 feet/day or 4.4 feet/year.

4.2 MIDDLE BELLFLOWER B SAND

Groundwater elevations and contours for the MBFB are presented on Figure 4. Groundwater elevations within the Site ranged from a high of -9.86 feet MSL at well SWL0003 (coordinates E4 on Figure 4) to a low of -10.93 feet MSL at well SWL0060 (coordinates J7). MBFB groundwater elevations were on average approximately 0.55 feet lower than for the previous 2012 monitoring event.

Based on the contours presented on Figure 4, groundwater flow in the MBFB is interpreted to be southeasterly in the vicinity of the Site at an average gradient of 0.0005. The average flow velocity calculated using the method outlined above (K = 20 feet/day; n = 0.15) is approximately 0.07 feet/day or 24 feet/year.

4.3 MIDDLE BELLFLOWER C SAND

MBFC groundwater elevations and contours are presented on Figure 5. MBFC groundwater elevations within the Site ranged from -9.95 feet MSL at well SWL0065 (coordinates F5) to -10.98 feet MSL at well SWL0040 (coordinates G7). Groundwater elevations were on average approximately 0.71 feet lower than for the previous 2012 monitoring event.

Groundwater flow in the MBFC is toward the south to south-southeast, under an average hydraulic gradient of approximately 0.0007. This flow direction is similar to that for the previous 2012 monitoring event. The average flow velocity calculated using the method outlined above (K = 163 feet/day; n = 0.15) is approximately 0.76 feet/day or 280 feet/year.

4.4 GAGE AQUIFER

Groundwater elevations and contours for the Gage aquifer are presented on Figure 6. Groundwater elevations within the Site ranged from -11.83 feet MSL at well XG-06 (coordinates C7) to -13.39 feet MSL at well SWL0022 (coordinates G7). Groundwater elevations were on average 0.10 feet lower than for the previous 2012 monitoring event.

Groundwater flow in the Gage is interpreted to be toward the east under an average hydraulic gradient of approximately 0.0006. Historically, the flow direction has been southeasterly. No significant change in the gradient has occurred. The average flow velocity is approximately 0.14 feet/day or 52 feet/year (K = 31 feet/day; n = 0.13).

4.5 HYDRAULIC HEAD

Data for co-located wells completed in different hydrostratigraphic units indicate that water levels are generally lower in successively deeper hydrostratigraphic units. Representative groundwater elevations for co-located wells completed in different hydrostratigraphic units can be compared in the following table:

Well Cluster Location	HSU	Well	2014 Groundwater Elevation (ft. MSL)
Western Plant Site Boundary	Water Table	PZL0016	-9.51
	MBFB	SWL0029	-10.03
	MBFC	SWL0030	-10.15
	Gage	SWL0031	Not available
Central Plant Site, Francisco St.	Water Table	SWL0016	-9.57
	MBFB	SWL0037	-10.31
	MBFC	SWL0035	-10.08
	Gage	SWL0036	-13.16
East of Plant site, Figueroa St.	Water Table	SWL0009	-7.42
	MBFB/C	SWL0010	-11.12
	Gage	SWL0025	-13.43

For a given location, water levels in the Water Table, MBFB, and MBFC are typically within a few feet of each other, while the level in the Gage is typically an additional two to four feet lower than the MBFC. The generally decreasing water levels with depth indicate a downward hydraulic gradient.

5.0 NON-AQUEOUS PHASE LIQUID

Non-Aqueous Phase Liquid (NAPL) has historically been present in Site Water Table wells XMW-20, SWL0001, and MBFB well SWL0032, which are all located in close proximity to each other near the western Site boundary. NAPL was observed in well SWL0032 with a thickness of 2.33 feet during the recent monitoring event (monitor wells XMW-20 and SWL0001 were not gauged during this monitoring event). Historical data indicates the NAPL near the western Site boundary to be composed almost entirely of benzene.

A viscous, black NAPL was detected at well PZL019 during the recent monitoring event with a thickness of 1.65 feet. Well PZL019 is located in the western end of the Waste Pits OU (coordinates E7 on Figure 7). The dissolved benzene concentration reported for the last groundwater monitoring event (December 2011) was 250,000 µg/l at this location (Table 3) but NAPL has never been previously observed. In accordance with Table 1 of the MACP, this well is included as part of the Waste Pits OU Performance Monitoring Program and will be discussed in more detail in the 2014 Waste Pit OU Annual Report.

6.0 GROUNDWATER SAMPLING AND ANALYTICAL RESULTS

6.1 SAMPLING AND ANALYTICAL METHODS

Groundwater samples for the recent monitoring event were collected between September 4 and 25, 2014. With the exception of well SWL0047, sampling and purging of each well was completed using a low-flow submersible pump and attached polyethylene tubing. For wells without dedicated pumps and tubing, a cleaned, temporary pump and new, disposable tubing was used. Well SWL0047 was observed to have oily debris in the well box and was therefore macro-purged to ensure formation water was sampled and minimize the potential for impacts from the surface contamination.

Water quality parameters, including pH, temperature, electrical conductivity, turbidity, oxidation reduction potential (ORP), and dissolved oxygen (DO) were measured and documented in the field during purging using a calibrated, multi-parameter water quality meter and are available upon request. Purging was conducted at a rate ranging from 200 to 400 milliliters per minute and continued until three consecutive measurements were within 10% of each other.

Purge water was stored in a temporary tank located at the Waste Pit OU pending waste profiling to determine appropriate off-site disposal. The purge water was subsequently transported by American Integrated Services as hazardous waste to Evoqua Water Technologies in Vernon, California for treatment and recycling. The waste disposal manifest is provided in Appendix A.

Samples were collected to be free of headspace in pre-cleaned, laboratory-supplied containers appropriate for the analyses to be completed. Samples were labeled immediately after collection and temporarily stored in a cooled ice chest pending same-day transport to the analytical laboratory under chain-of-custody protocol.

All groundwater sample analyses were completed by Eurofins Calscience of Garden Grove, California. VOCs, including TBA, were analyzed using USEPA Method 8260B. Biodegradation indicator analyses performed by the laboratory included tests for methane by RSK-175M, ferrous iron by SM 3500-FeB, sulfate and nitrate by USEPA Method 300.0, total alkalinity by SM 2320B, and carbon dioxide by SM4500-CO2D.

6.2 OVERVIEW AND DATA PRESENTATION FORMAT

Groundwater analytical results are discussed below for the Water Table, MBFB, MBFC and Gage units. Discussion of VOC concentrations and plume distributions is limited to concentrations associated with the Site and is focused on benzene, the principal groundwater

COC associated with the Site based on its distribution, magnitude of concentrations, and relative toxicity.

Table 3 presents a time-series summary of detected analytes for wells in the Site vicinity. The table is limited chronologically to the data generated since the 2006 comprehensive monitoring event through the recent 2014 event. Comprehensive reporting of analytical data for the recent monitoring event is presented electronically in Appendix B.

The dissolved benzene plumes and associated concentration data from the 2014 Baseline Sampling Event for the Water Table, MBFB, MBFC and Gage hydrostratigraphic units are presented on Figures 7, 8, 9, and 10 respectively. These figures include data collected by URS for the Site MACP as well as data collected by other investigators. Where 2014 data is not available, the most recent historical data is presented, dating back to a comprehensive monitoring event conducted in 2006. Sampling locations with current data are distinguished from those with historical data by the well symbol, as indicated in the legend for each figure.

The ROD defines the benzene plume as "*the portion of the distribution of benzene in groundwater at the Joint Site that is not comingled with chlorobenzene. Put another way, the benzene plume is that benzene within the Joint Site that lies outside of the chlorobenzene plume…*". The dissolved benzene plumes presented in the figures are based on this ROD definition, and illustrate the extent of benzene associated with historical releases from the Site. While benzene concentration data are presented on the figures for the area within the ROD-defined chlorobenzene plume, the benzene within this area is not attributed to the Site, and no isoconcentration lines or additional interpretation of these data is provided. Similarly, benzene present in other off-site plumes that are clearly discontinuous from the Site are also not associated with the Site and are not interpreted.

6.3 BENZENE DISTRIBUTION

6.3.1 Water Table

The interpreted Water Table dissolved benzene distribution is presented on Figure 7. The dissolved benzene distribution is generally consistent with historical data. Beginning with the previous 2012 monitoring event and continuing through the recent monitoring event, the dissolved benzene plume in the vicinity of the Waste Pits OU is significantly reduced relative to historical events.

Dissolved benzene known to be associated with the Site is entirely within the TI-Waiver Zone. The benzene detection at well PZL0005 at the northeastern Site boundary (17 µg/l in 2008) is outside the TI-Waiver Zone, but its origin is unknown. Benzene was not detected at this location in the previous nine sampling events between March of 1993 and February of 1996. Given this history and the location of the well along the hydrologically upgradient side of the

plant site, the detected benzene may be associated with an off-site source rather than the Site, or the 2008 result may be anomalous. Based on this uncertainty, PZL0005 will be sampled during the 6-month after TGRS start-up monitoring event to allow further evaluation.

As reflected on Figure 7, dissolved benzene concentrations in the southwest corner of the Site and on the Montrose site are not associated with historical Site operations based on the coincident presence of chlorobenzene and chlorinated solvents.

To assess benzene concentration trends at the Site, a Mann-Kendall analysis was completed. Mann-Kendall is a non-parametric method, meaning that there is no assumption of a statistical distribution (e.g., normal distribution). Most groundwater data is not distributed normally, due to left censoring (no values recorded below the detection limit) and the occasional very high concentration, orders of magnitude above the detection limit. Mann-Kendall statistical analysis was performed for wells with a history of benzene detections since initiation of groundwater monitoring activities. The analysis was completed for both the short term (last 8 sampling events) and long term (last 16 sampling events). Wells for which trends of increasing or decreasing benzene concentrations were identified are indicated below. For all other wells, a trend was either not identified or there was insufficient data for analysis. Historical data spreadsheets, concentration trend plots, and results pertaining to the Mann-Kendall analysis are provided in Appendix C.

Short Term Trends		**Long Term Trends**	
Decreasing Concentrations	**Increasing Concentrations**	**Decreasing Concentrations**	**Increasing Concentrations**
PZL0009 PZL0011 PZL0013 PZL0020 PZL0026 SWL0003 SWL0004 SWL0008 SWL0044 SWL0051 XMW-04HD XMW-28 XMW-29		PZL0020 SWL0008	none

Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at 32 of the 47 wells sampled. Based on these findings, the dissolved benzene plume is stable to decreasing.

6.3.2 Middle Bellflower B Sand

MBFB benzene data are summarized on Figure 8. The MBFB plume is not discussed at length here since the Water Table and the MBFB water-bearing units are identical in the western portion of the Site and further west. Further east, the MBFB dissolved benzene plume is similar to the Water Table dissolved benzene plume, but with a significantly reduced distribution. The overall dissolved benzene plume distribution is similar to that for previous monitoring events and the portion attributable to plant site sources remains within the TI-Waiver Zone.

A Mann-Kendall analysis was completed as described in Section 6.3.1 to identify MBFB wells with benzene concentration trends and the results of the analysis are summarized below. Associated historical data spreadsheets, concentration trend plots, and results are provided in Appendix C.

Short Term Trends		Long Term Trends	
Decreasing Concentrations	**Increasing Concentrations**	**Decreasing Concentrations**	**Increasing Concentrations**
None	SWL0048	None	None

Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at 12 of the 15 wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.

6.3.3 Middle Bellflower C Sand

Benzene results for the MBFC are summarized on Figure 9. MBFC benzene concentrations tend to be lower than in the overlying Water Table and MBFB. Dissolved benzene associated with the Site occurs in three distinct plume areas, with their respective concentration maxima occurring at wells SWL0065 (coordinates F6 on Figure 9), SWL0040 (Coordinates G7), and SWL0060 (coordinates J7), respectively.

The SWL0065 dissolved benzene plume is inferred to be associated with releases from the former styrene plancor portion of the Site and roughly corresponds to larger, higher concentration plume areas in the overlying Water Table and MBFB. The dissolved benzene plume at well SWL0040 is likely associated with the Waste Pits OU and/or or adjacent petroleum pipelines along the southern Site boundary that are unrelated to the Site. The dissolved benzene plume at SWL0060 is inferred to be associated with Site pipeline releases and overlying NAPL-impacted soil.

Each of the three plume areas discussed above are considered to be within the MBFC TI-Waiver Zone. While the ROD does not depict the MBFC TI-Waiver Zone in the vicinity of well

SWL0060 (see ROD Figure 10-1), the dissolved benzene plume in this area is still considered to be within the TI-Waiver Zone for the following reasons:

- The ROD indicates an MBFB TI-Waiver Zone in this area;
- The MBFB and MBFC are merged and relatively thin in the vicinity of well SWL0060 so that the well is considered to be screened in both units; and
- The ROD defines the MBFC TI-Waiver Zone as the projection of the lateral boundary of the dissolved benzene plume in the MBFB onto the underlying MBFC (see page 10-11 of the ROD).

The largest distribution of the MBFC dissolved benzene extends over the southwestern corner of the Site, but is inferred to emanate from sources unrelated to the Site based on the plume geometry, groundwater flow direction, and coincident high concentrations of chlorobenzene. This area is within the chlorobenzene plume and not the benzene plume using the ROD-defined terminology.

A Mann-Kendall analysis was completed as described in Section 6.3.1 to identify MBFC wells with benzene concentration trends and the results of the analysis are summarized below. Associated historical data spreadsheets, concentration trend plots, and results are provided in Appendix C.

Short Term Trends		Long Term Trends	
Decreasing Concentrations	**Increasing Concentrations**	**Decreasing Concentrations**	**Increasing Concentrations**
SWL0054 XBF-13	None	None	None

Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at 10 of the 16 wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.

6.3.4 Gage Aquifer

Benzene results for the Gage aquifer are summarized on Figure 10. The dissolved benzene plume attributed to the Site is centered at well SWL0066 and is associated with overlying, larger areas of higher benzene concentration in the Water Table, MBFB and MBFC. Benzene present in the southwest corner of the Site and further south is part of the chlorobenzene plume under the ROD terminology and is interpreted to be associated with the Montrose site based on the plume geometry, groundwater flow direction, and coincident high concentrations of chlorobenzene.

Since wells SWL0063 and SWL0066 were not constructed until after the ROD was completed, the dissolved benzene plume in this area of the Site is located outside of the Gage aquifer TI-Waiver Zone indicated in the ROD. However, the extent of the dissolved benzene plume is

limited and future analytical laboratory testing will be utilized to monitor the benzene concentration trends and extent of the plume.

A Mann-Kendall analysis was completed as described in Section 6.3.1 to identify Gage wells with benzene concentration trends. No concentration trends were identified. Benzene concentrations were not detected or detected at concentrations below the MCL (1 µg/l) at three of the five wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.

6.4 TERTIARY BUTYL ALCOHOL

A subset of wells analyzed for VOCs were selected for additional TBA analysis. Wells were selected for TBA analysis where a) TBA was previously detected, as indicated in the 2012 groundwater monitoring report (URS, 2012); b) TBA is potentially present based on the well location within the interpreted TBA plume presented in the 2012 monitoring report; and c) USEPA specifically requested TBA analysis (see USEPA comment letter of August 18, 2014). Results of TBA analyses are summarized in Table 3.

6.5 BIODEGRADATION INDICATORS

Degradation of dissolved hydrocarbons can be facilitated by certain species of microorganisms indigenous in the subsurface. These microbes obtain energy by metabolizing and breaking down hydrocarbons that have been introduced into the environment. The microbes extract energy by facilitating the transfer of electrons from the hydrocarbon (an electron donor) to oxidized elements in the environment that are electron acceptors. Common electron acceptors in the saturated zone include DO, nitrate, ferric iron (Fe^{+++}), sulfate, and carbon dioxide. Thus, depleted concentrations of these elements and compounds coincident with hydrocarbon contamination serve as indicators of biodegradation. In some cases, it can be more convenient and/or accurate to measure increased concentrations of the byproducts of the chemical reduction process rather than decreased concentrations of the electron acceptors. For example, instead of measuring decreases in the concentrations of ferric iron (Fe^{+++}) or carbon dioxide, increases in concentrations of ferrous iron (Fe^{++}) and methane can be measured, which are equally valid biodegradation indicators. Additionally, elevated levels of alkalinity can be used as an indicator of benzene biodegradation.

Specific environmental conditions dictate which, if any, biodegradation pathways are active so that not all indicators will necessarily be observed at a site. However, aerobic respiration and consumption of DO is typically the first process. After oxygen depletion, degradation by anaerobic microorganisms through denitrification, reduction of iron and sulfate, and methanogenesis pathways may occur.

Biodegradation indicator analyses completed for the Baseline Groundwater Monitoring Event included tests for DO, ORP, carbon dioxide, methane, nitrate, sulfate, ferrous iron, and total alkalinity. DO, ORP and carbon dioxide data are used in evaluating aerobic biodegradation. The laboratory analyses for nitrate, ferrous iron, sulfate, methane are specific to anaerobic degradation pathways. The remaining analysis for total alkalinity can be used for either aerobic or anaerobic degradation.

Locations for which biodegradation indicator analyses were completed included 13 Water Table wells and six MBFB wells along the transects indicated on Figures 7 and 8. These transects typically provide data for positions up-gradient of the dissolved benzene plume, within the dissolved benzene plume, at the down-gradient fringe of the dissolved benzene plume, and down-gradient or cross-gradient of the dissolved benzene plume. Biodegradation indicator data are included in Table 3 and graphs presenting the data relative to the transect lines and position of the wells relative to the plumes are presented in Figures 11 through 15.

A simplified summary of the biodegradation data is presented in the table below, wherein each of the indicators is identified with respect to the expected mid-plume value (where high benzene concentrations are present) relative to the values outside of the plume. An "X" indicates a strong indication, wherein the expected relationship is achieved at multiple locations, and an "O" indicates where there is partial agreement. A dash (-) indicates the data are not indicative of biodegradation for that pathway.

Biodegradation Process	Indicator	Mid-plume Biodegradation Indication	Transect Occurrences				
			WT-1	WT-2	WT-3	WT-4	MBFB-1
Aerobic	Oxygen Concentration	Reduced	O	O	O	X	O
	ORP value	Reduced	X	X	X	X	O
	Carbon Dioxide Concentration	Increased	O	X	O	X	O
Anaerobic	Ferrous Iron Concentration	Increased	X	X	O	X	O
	Methane Concentration	Increased	X	O	X	O	O
	Nitrate Concentration	Decreased	O	X	-	O	-
	Sulfate Concentration	Decreased	X	X	X	X	O
	Alkalinity Concentration	Increased	X	X	O	X	X

As shown in the table, there is an overall indication that both aerobic and anaerobic biodegradation processes are occurring, with the ORP, sulfate, and alkalinity data being the

strongest indicators. This result, combined with the previously discussed findings indicating that Site benzene plumes have not migrated outside the TI-Waiver Zone and the Mann-Kendall statistical analysis indicating trends of decreasing benzene concentrations at multiple Water Table and MBFB wells confirms that the natural monitored intrinsic biodegradation remedial approach identified in the ROD is appropriate.

6.6 QA/QC DATA AND EVALUATION

Quality Assurance/Quality Control (QA/QC) samples analyzed as part of the monitoring program included four field blanks, 14 equipment blanks, 15 trip blanks, and eight field duplicate samples. The equipment blanks consisted of laboratory provided, organic-free water that was poured over a cleaned, non-dedicated pump into sample vials. Analysis of these samples permits evaluation of potential cross-contamination between sampling locations. The trip blanks were laboratory-prepared vials of organic-free water that remained with the primary sample containers during transit to and from the site, and during sampling. The trip samples are not opened at any time during the field investigation, and their purpose is to allow evaluation of cross-contamination from laboratory sources as well as between sample containers. Duplicate samples are collected at the same time and location as a corresponding primary sample, and are used to evaluate the reproducibility of the laboratory analyses.

QA/QC samples were analyzed for the same constituents and by the same method (USEPA Method 8260) as for the corresponding primary samples. All compounds were below detection limits in each of the equipment blank and trip blank samples indicating that no cross contamination occurred. Duplicate samples were collected for locations PZL0010, SWL0002, SWL0003, SWL0021, SWL0050, SWL0065, XWM-04HD, and XP-03. Comparison of the primary and duplicate sample results for these locations is provided in Table 4.As indicated in the table, the relative percent difference between the primary and duplicate sample concentrations are all well below the 50% criteria for acceptance without qualification.

Based on the equipment blank, trip blank, and field duplicate sample results described above and other criteria described in the Data Validation Memorandum presented in Appendix D, the data presented in this report are judged adequate for their intended purpose.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Presented in this document are the results of the 2014 Baseline Groundwater Monitoring Event completed in September 2014 for the Site, which were conducted in accordance with the September 5, 2014 MACP. The monitoring program is being conducted to generate groundwater elevation and laboratory analytical data by which to evaluate the extent of the contaminant plume associated with the Site and confirm that biodegradation and containment of the dissolved benzene plume is occurring.

The following conclusions are presented based on the data gathered during the 2014 Baseline Groundwater Monitoring Event:

- Groundwater Elevations and Flow:
    - Water table elevations within the Site ranged from a high of -8.56 feet MSL at well SWL0038 in the northwest corner, to a low of -10.57 feet MSL at well XMW-28, near the southwest corner. Groundwater elevations were on average approximately 0.57 feet lower than those for the previous monitoring event in 2012. The flow direction is generally southwesterly at an average gradient of 0.0006 and velocity of approximately 0.01 feet/day or 4.4 feet/year.
    - MBFB elevations within the Site ranged from a high of -9.86 feet MSL at well SWL0003 to a low of -10.93 feet MSL at well SWL0060. Groundwater elevations were on average approximately 0.55 feet lower than for the previous 2012 monitoring event. The flow direction is generally to the southeast at an average gradient of 0.0005 and velocity of approximately 0.07 feet/day or 24 feet/year.
    - MBFC groundwater elevations within the Site ranged from -9.95 feet MSL at well SWL0065 to -10.98 feet MSL at well SWL0040. Groundwater elevations were on average approximately 0.71 feet lower than for the previous 2012 monitoring event. The flow direction is generally to the south-southeast at an average hydraulic gradient of approximately 0.0007 and velocity of approximately 0.76 feet/day or 280 feet/year.
    - Gage Aquifer groundwater elevations within the Site ranged from -11.83 feet MSL at well XG-06 to -13.39 feet MSL at well SWL0022. Groundwater elevations were on average 0.10 feet lower than for the previous 2012 monitoring event. The flow direction is generally to the east at an average hydraulic gradient of approximately 0.0006 and velocity of approximately 0.14 feet/day or 52 feet/year.
    - Groundwater elevation data for co-located wells completed in different hydrostratigraphic units indicate that water levels are generally lower in successively deeper hydrostratigraphic units, indicating a downward hydraulic gradient.

- NAPL:
    - NAPL has historically been present in Site water table wells XMW-20, SWL0001 and MBFB well SWL0032, which are all located near the western Site boundary. NAPL was observed in well SWL0032 during the recent monitoring event (monitor wells XMW-20 and SWL0001 were not gauged during this monitoring event). Historical data indicates the NAPL near the western Site boundary to be composed almost entirely of benzene.
    - NAPL was detected at well PZL019 during the recent monitoring event, with a thickness of 1.65 feet. Well PZL019 is located in the western end of the Waste Pits OU and NAPL has not previously been observed in this well. In accordance with Table 1 of the MACP, this well is included as part of the Waste Pits OU Performance Monitoring Program and will be discussed in more detail in the 2014 Waste Pit OU Annual Report.
- Benzene Distribution – Water Table:
    - While the dissolved benzene distribution is generally consistent with historical data, benzene concentrations and distribution are reduced in the vicinity of the Waste Pits OU.
    - Dissolved benzene known to be associated with the Site is entirely within the TI-Waiver Zone. The origin of benzene detected at well PZL0005 in the northeast corner in 2008 (17 µg/l) is unknown, but may originate from off-site given the southwesterly direction of groundwater flow in this area. Benzene was not detected at this location in any previous monitoring events and the anomalous result from 2008 will be further evaluated by sampling this well during the 6-month after TGRS start-up sampling event.
    - Mann-Kendall statistical analysis identified 13 wells with a trend of decreasing benzene concentrations through time and no wells with increasing concentrations. Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at 32 of the 47 wells sampled. Based on these findings, the dissolved benzene plume is stable to decreasing.
    - Biodegradation indicators confirmed that there is an overall indication that both aerobic and anaerobic biodegradation processes are occurring, and this data combined with the observed benzene distribution and identified trends of decreasing benzene concentrations confirm that the monitored intrinsic biodegradation remedial approach identified in the ROD is appropriate.
- Benzene Distribution - MBFB:
    - The dissolved benzene distribution is generally consistent with historical data and the dissolved benzene plume is entirely within the TI-Waiver Zone. The dissolved benzene concentrations observed in the southwest corner of the Site and on the Montrose site are not associated with historical Site operations based on the coincident presence of chlorobenzene and chlorinated solvents.

  - Mann-Kendall statistical analysis identified no wells with a trend of decreasing benzene concentrations through time and one well with increasing benzene concentrations. Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at 12 of the 15 wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.
  - Biodegradation indicators confirmed that there is an overall indication that both aerobic and anaerobic biodegradation processes are occurring, and these data combined with the observed benzene distribution and the dissolved benzene concentration trends confirm that the monitored intrinsic biodegradation remedial approach identified in the ROD is appropriate.
- Benzene Distribution - MBFC Sand:
  - The dissolved benzene distribution is generally consistent with historical data and dissolved benzene concentrations tend to be lower than in the overlying water table and MBFB water-bearing units.
  - The dissolved benzene plume associated with the Site is entirely within the TI-Waiver Zone.
  - The dissolved benzene concentrations observed in the southwest corner of the Site and in the vicinity of the Montrose site are not associated with the Site based on the coincident presence of chlorobenzene and chlorinated solvents.
  - Mann-Kendall statistical analysis identified two wells with a trend of decreasing benzene concentrations through time and no wells with increasing concentrations. Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at 10 of the 16 wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.
- Benzene Distribution - Gage Aquifer:
  - The dissolved benzene distribution is generally consistent with historical data and dissolved benzene concentrations tend to be lower than in the overlying water table, MBFB and MBFC water-bearing units.
  - The dissolved benzene concentrations observed in the vicinity of the southwest corner of the Site and the Montrose site are not associated with historical Del Amo operations based on the coincident presence of chlorobenzene and chlorinated solvents. Wells SWL0066 and SWL0063 were not constructed until after the ROD was completed; therefore, the dissolved benzene plume is located outside of the TI-Waiver Zone indicated in the ROD. However, the extent of the plume is limited and future analytical laboratory testing will be utilized to monitor the benzene concentration trends and extent of the plume
  - Mann-Kendall statistical analysis did not identify any wells with trends of either increasing or decreasing concentrations. Benzene concentrations were not detected or detected at concentrations below the MCL (< 1 µg/l) at three of the

five wells sampled. Based on this finding, the dissolved benzene plume is stable to decreasing.

Based on the conclusions presented above, 17 wells are recommended for destruction and an additional four wells are recommended for transfer to other parties. One well is recommended for inclusion in the 6-month sampling event. The individual wells with their associated recommendation and rationale are summarized in the table below:

HSU	Well	Recommendation	Rationale
Water Table	PZL0002	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0003	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0004	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0005	Gauge and sample well in 6-month event	Further evaluate anomalous benzene detection in 2008 sampling event
	PZL0008	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0015	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0017	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	PZL0019	Continue gauging	NAPL present
	SWL0012	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0015	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0028	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0039	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0049	Transfer to Montrose	Not necessary for monitoring of Del Amo benzene plume
	SWL0057	Destroy well	Established history of benzene concentrations below the MCL
MBFB	SWL0011	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0019	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0052	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0056	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
MBFC	SWL0014	Destroy well	Outside of TI Waiver Zone with a history of benzene concentrations below the MCL
	SWL0033	Transfer to Montrose	Contaminants present not associated with Del Amo Site
LBF	SWL0043	Destroy well	Not screened in major HSU; no history of benzene concentrations in excess of MCL
Gage	SWL0031	Previously destroyed by PACCAR	
	SWL0034	Transfer to Montrose	Contaminants present not associated with Del Amo Site
	SWL0067	Transfer to TCE parties	Established history of benzene concentrations below the MCL; TCE present not associated with Del Amo Site

8.0 REFERENCES

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